Last Engineering Run

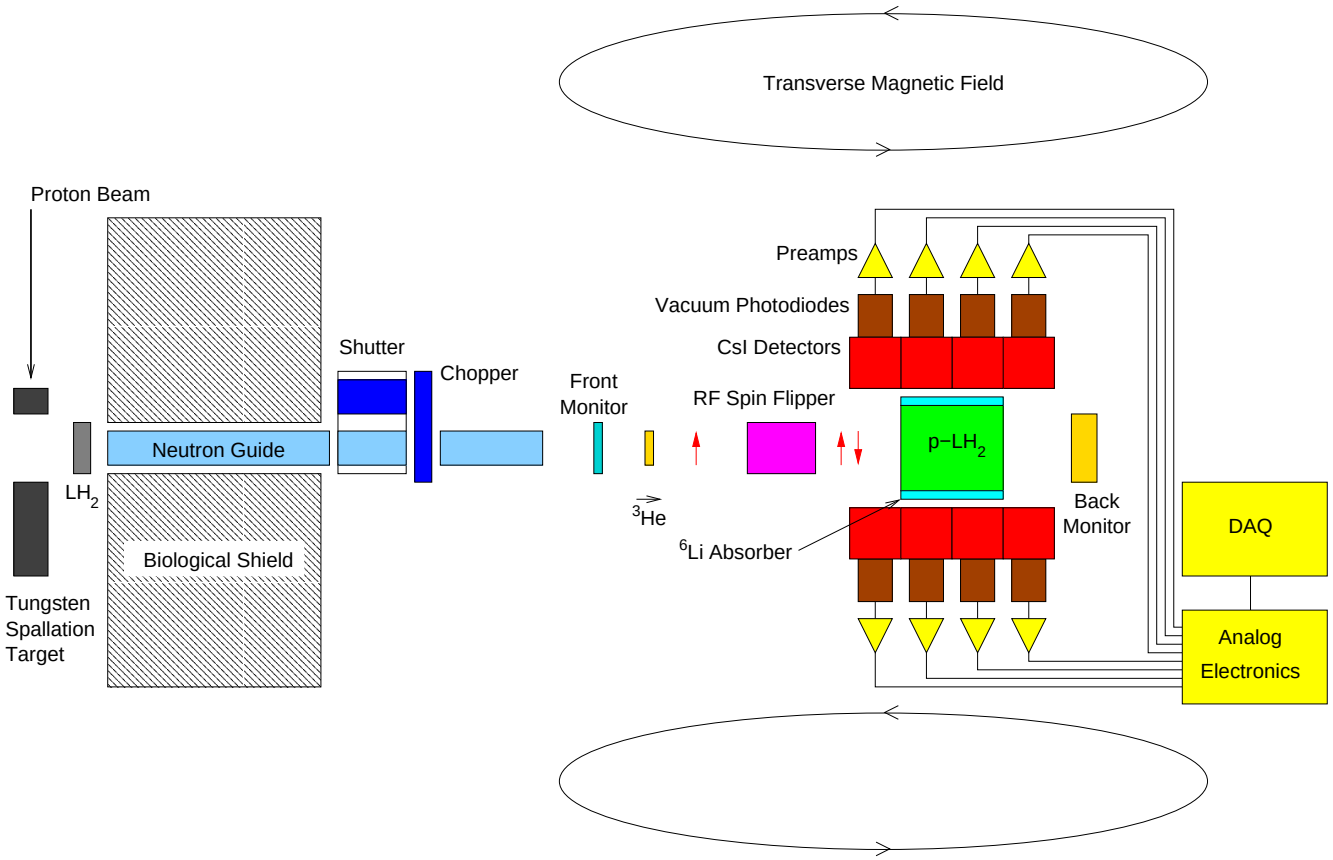
for the NPDGamma Experiment

$$\overrightarrow{n} + p \rightarrow d + \gamma$$

Request 20011538

April 19, 2001

NPDGamma Experimental Setup



$$d\omega/d\Omega = \frac{1}{4\pi}(1 + A_\gamma \cos\theta_{s,\gamma})$$

NPDGamma is an approved & funded ($3.5M) experiment

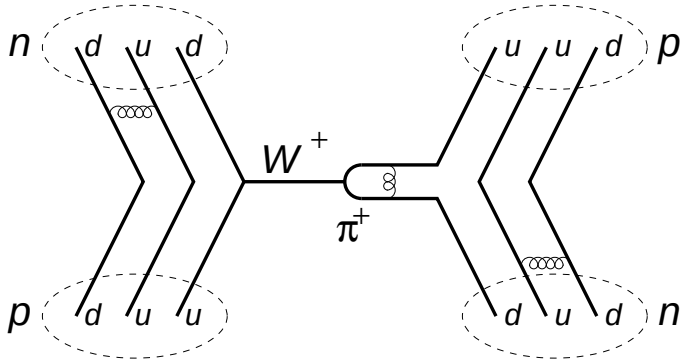
NPDGamma: $\vec{n} + p \rightarrow d + \gamma$

Measure parity-violating asymmetry A_γ in capture of polarized cold n by para-H_2

Expected asymmetry $\approx 5 \times 10^{-8}$

target experimental error: 0.5×10^{-8}

A_γ is a clean measurement of H^1_π,
the largest weak nucleon-nucleon coupling,
a fundamental quantity in low-energy QCD
and weak interaction physics



NPDGamma building FP12 to be ready for:

commissioning run Fall 2002

production data taking 2003

2001 (Last) Engineering Run on FP11A will study the following:

- DAQ & detector improvements to demonstrate design noise levels in situ
- Improvements in ^{3}He neutron spin filter
- New fission chamber flux monitor
- Moderator brightness
- Beam intensity fluctuations
- Detector alignment scheme

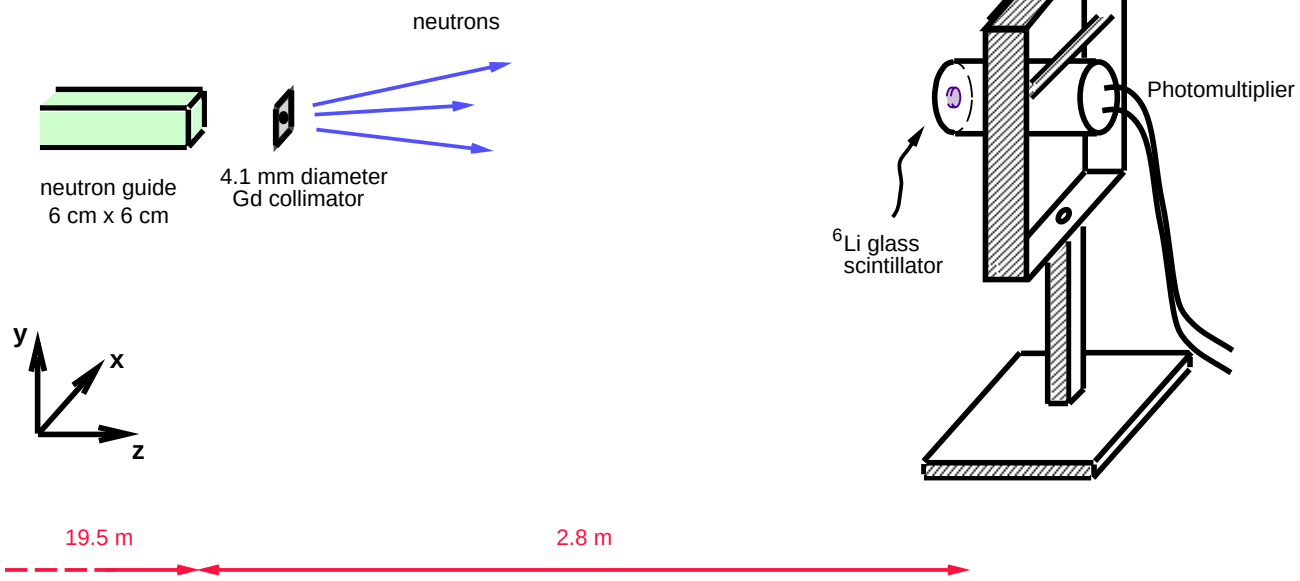
Fall 2000 Test Run successfully tested 1/10th scale apparatus, made physics measurements of PV neutron capture (Cl, La, Cd)

NPDGamma Fall 2000 Test Run
FP11A

- measured n flux to benchmark Monte Carlo
- verified n intensity fluctuations to be small
- polarized a neutron beam with a ^{3}He spin filter (thickness 6 atm·cm, $P \approx 26.5\%$)
- measured RF spin flipper efficiency ($> 95\%$) vs. energy and position
- used transmission back monitor ($^3He/H_2$) to observe beam intensity and measure RFSF characteristics
- measured parity-violating neutron capture asymmetries in Cl, La, Cd, to $\pm 2.5 \times 10^{-6}$ (stat.), $\pm$few $\times 10^{-7}$ (syst.) in eight hours data taking per target, using four CsI(Tl) current mode γ detectors and 3" vacuum photodiodes, and VME-based DAQ system

Neutron Flux Measurement (FP11A, Fall 2000)

Measured the flux by collimating the beam and counting with a small detector on a movable stage

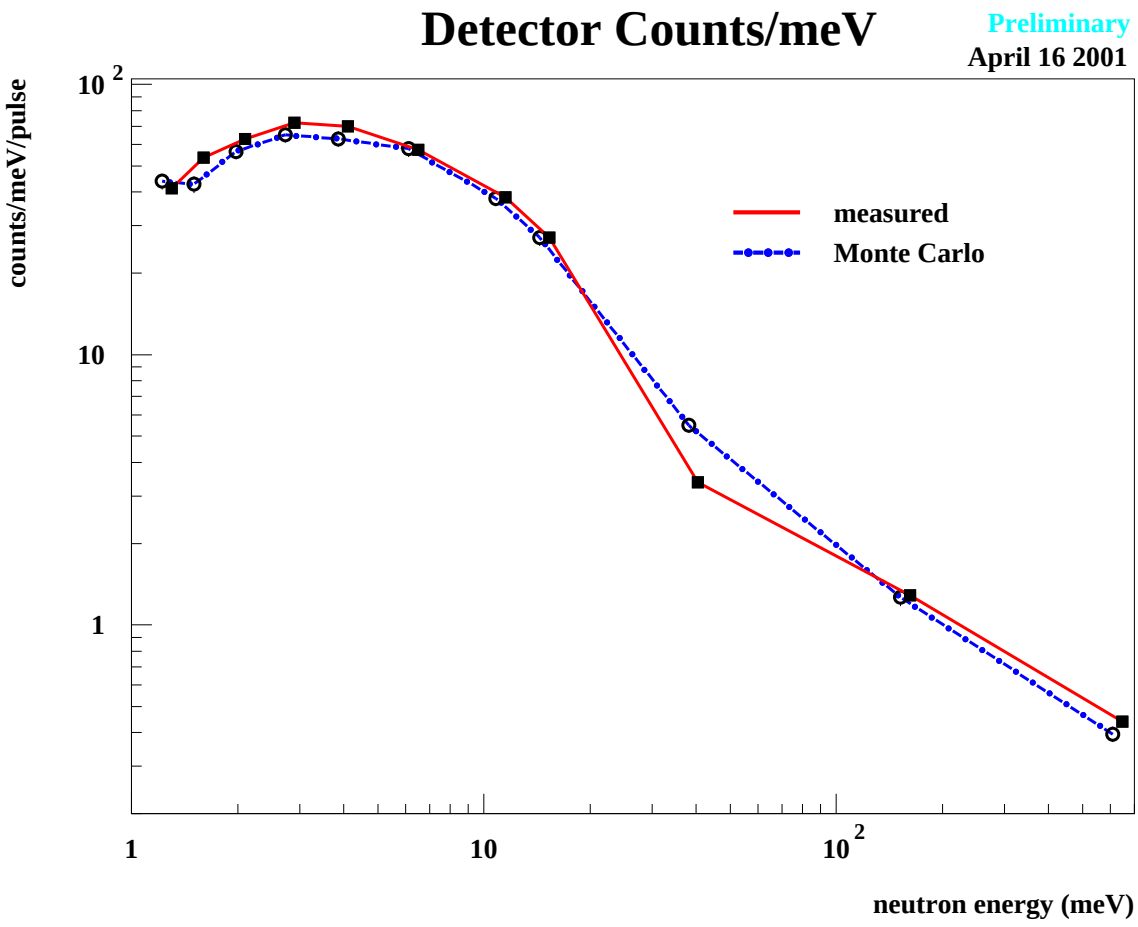


Compare measured flux to predicted flux for a decoupled LH_2 moderator, using a Monte Carlo to calculate neutron guide transport and collimation effects for FP11A

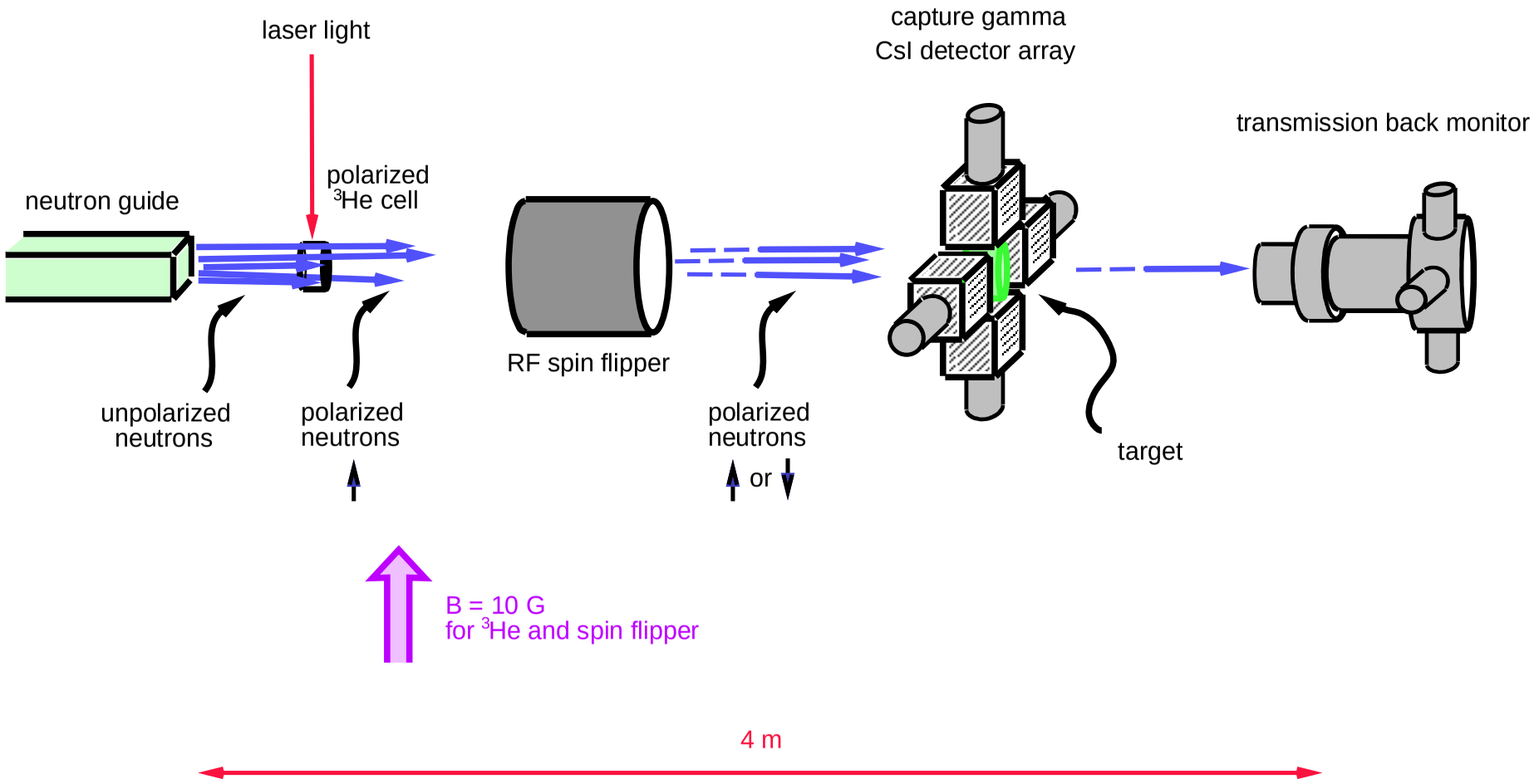
(the moderator brightness prediction is a LAHET calculation by LANSCE)

Excellent agreement $\sim$ 20%

$\longrightarrow$ FP12 flux will be as assumed for NPDGamma, and have a demonstrated method to measure it



NPDGamma Fall 2000 Test Run Setup



^{3}He Spin Filter

Double cell:

warm side for optical pumping of Rb vapor,

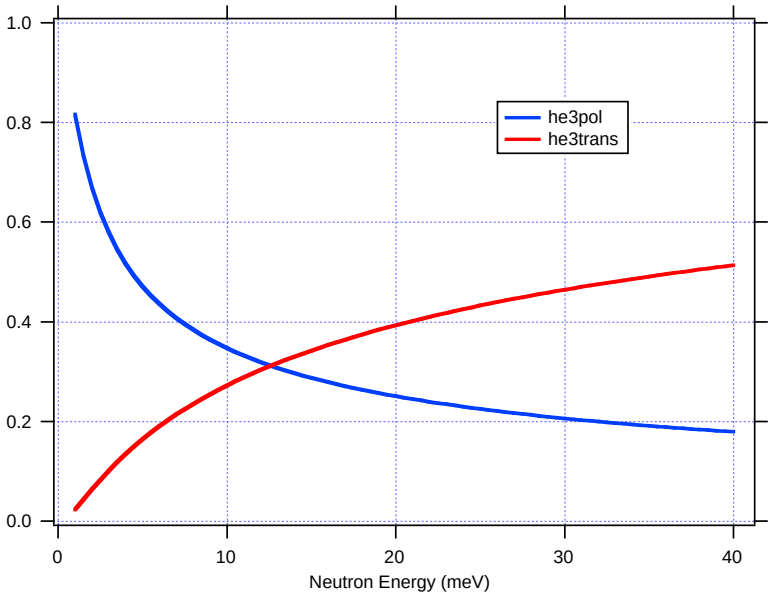
cold side for polarizing neutrons

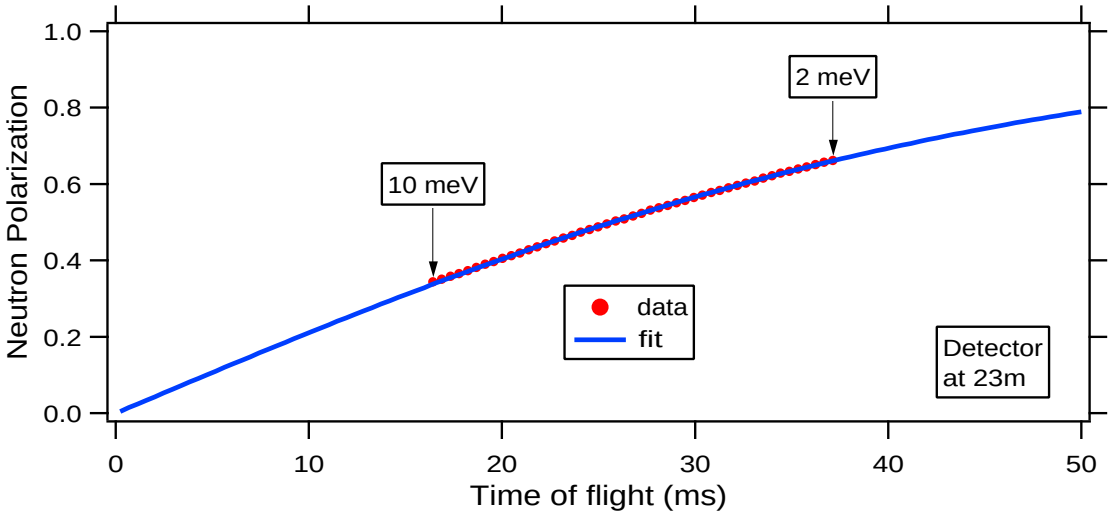
^{3}He polarization of 26.5% $\Longrightarrow$

n polarization of 30-70% for 2-10 meV

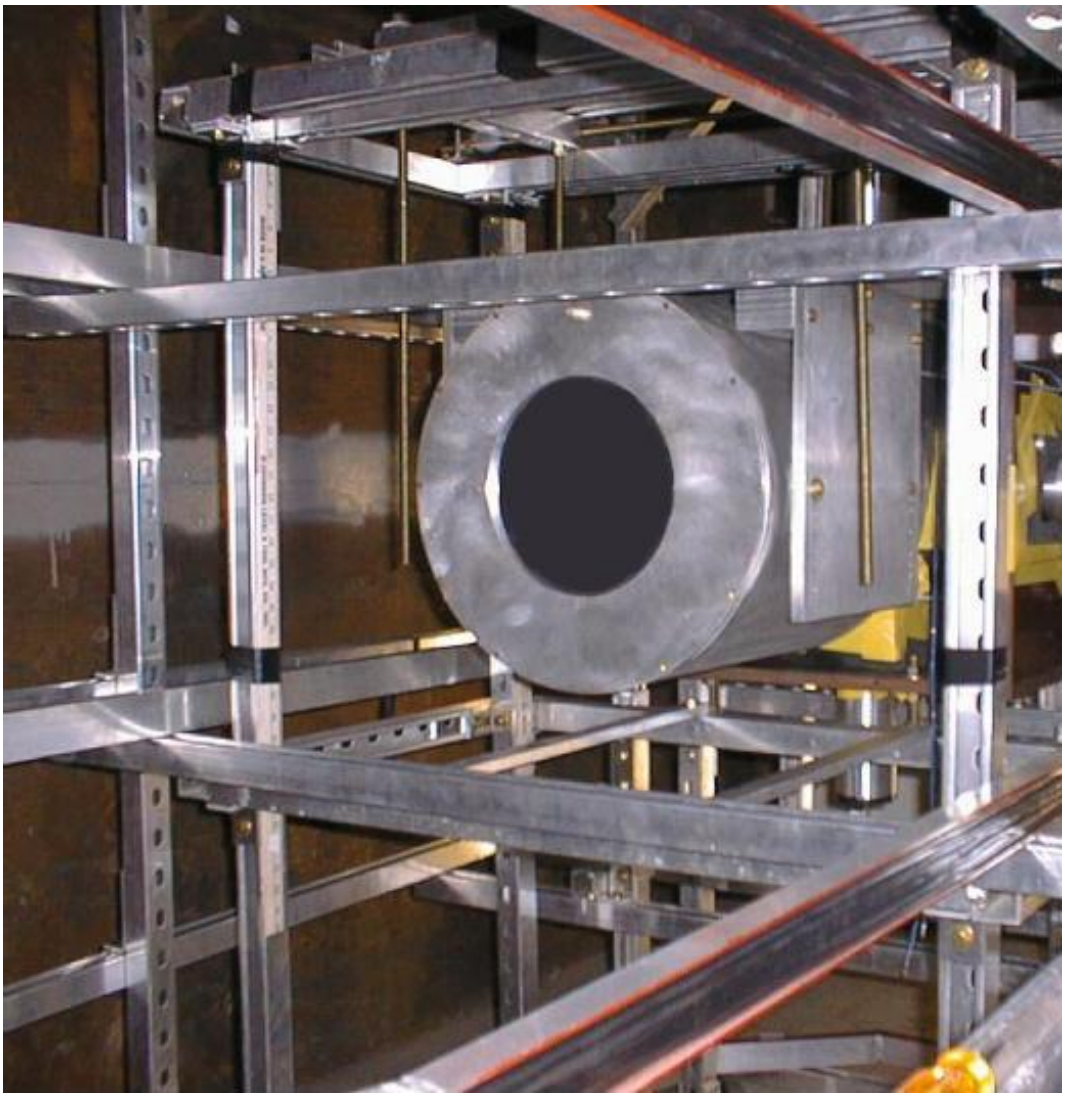
^{3}He system $\longrightarrow$ polarized neutron beam

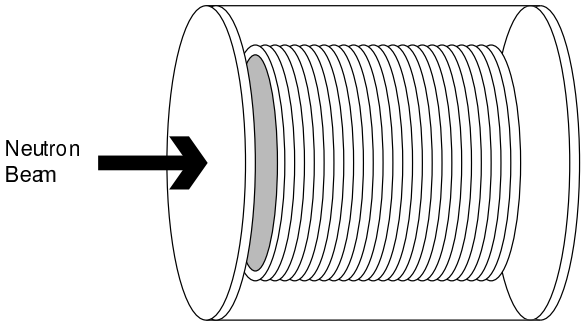
Transmission & polarization depend on neutron energy in a well-understood way



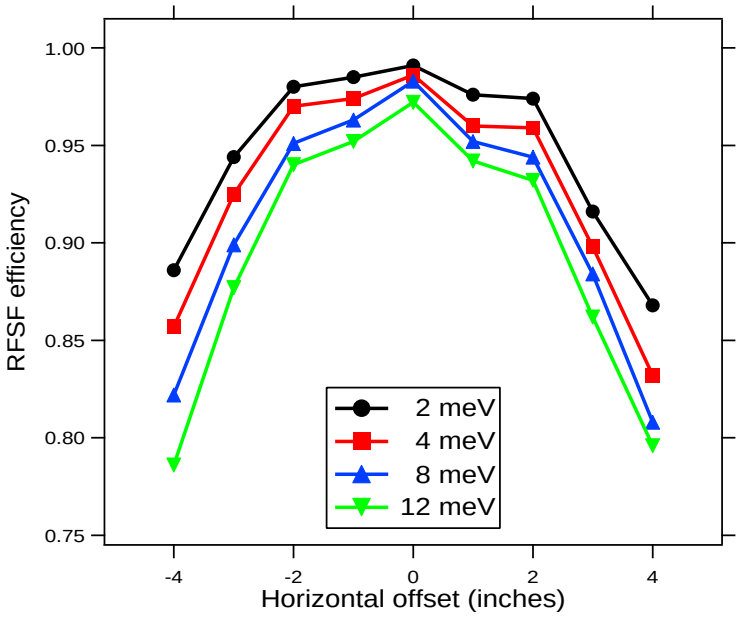


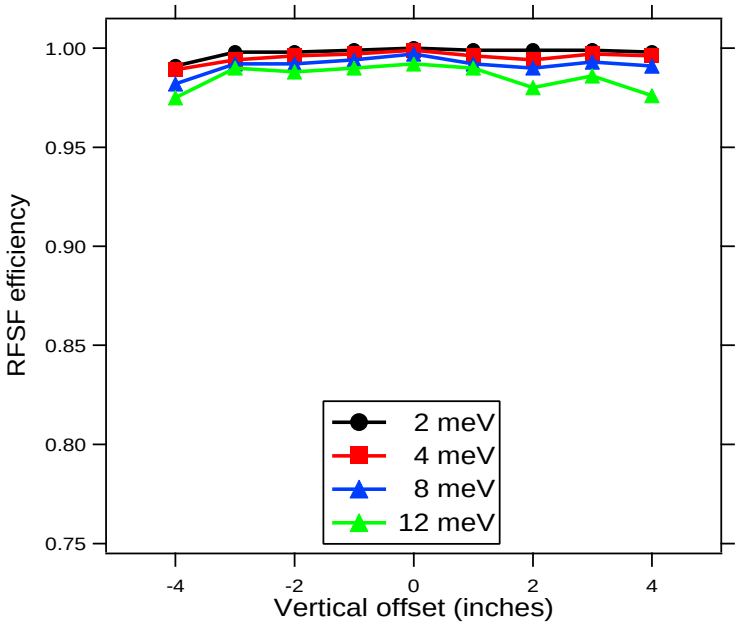
Radio Frequency Spin Flipper





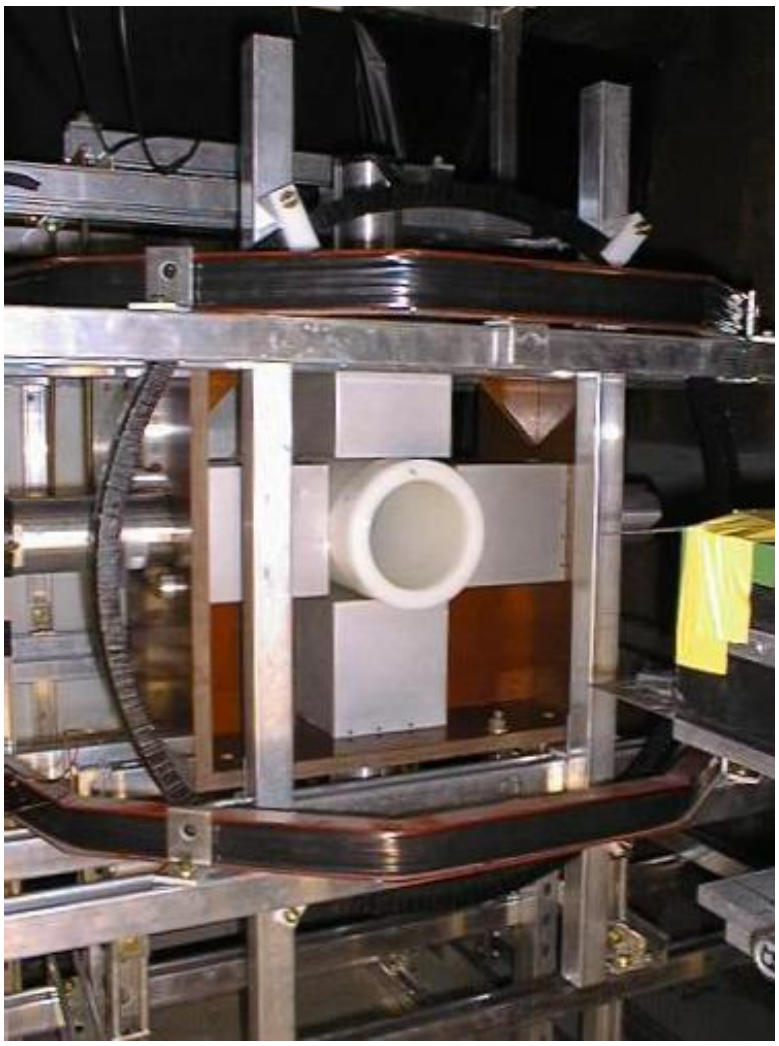
Spin flipper efficiency versus position
very good (>95% on axis)

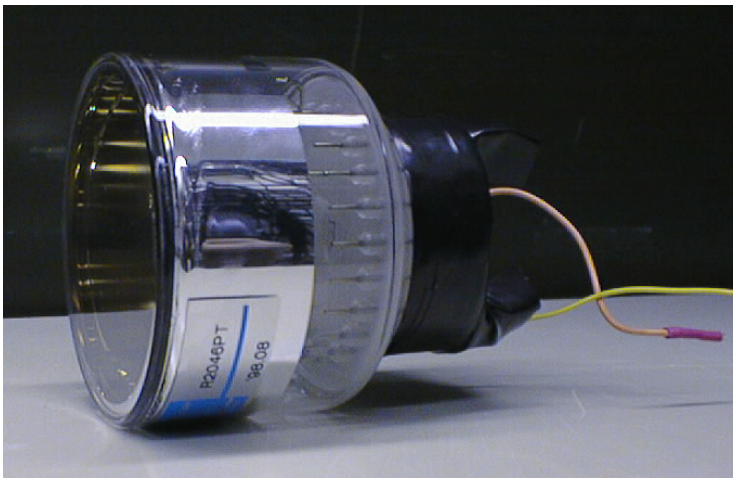




CsI(Tl) and Photodiode γ Detectors

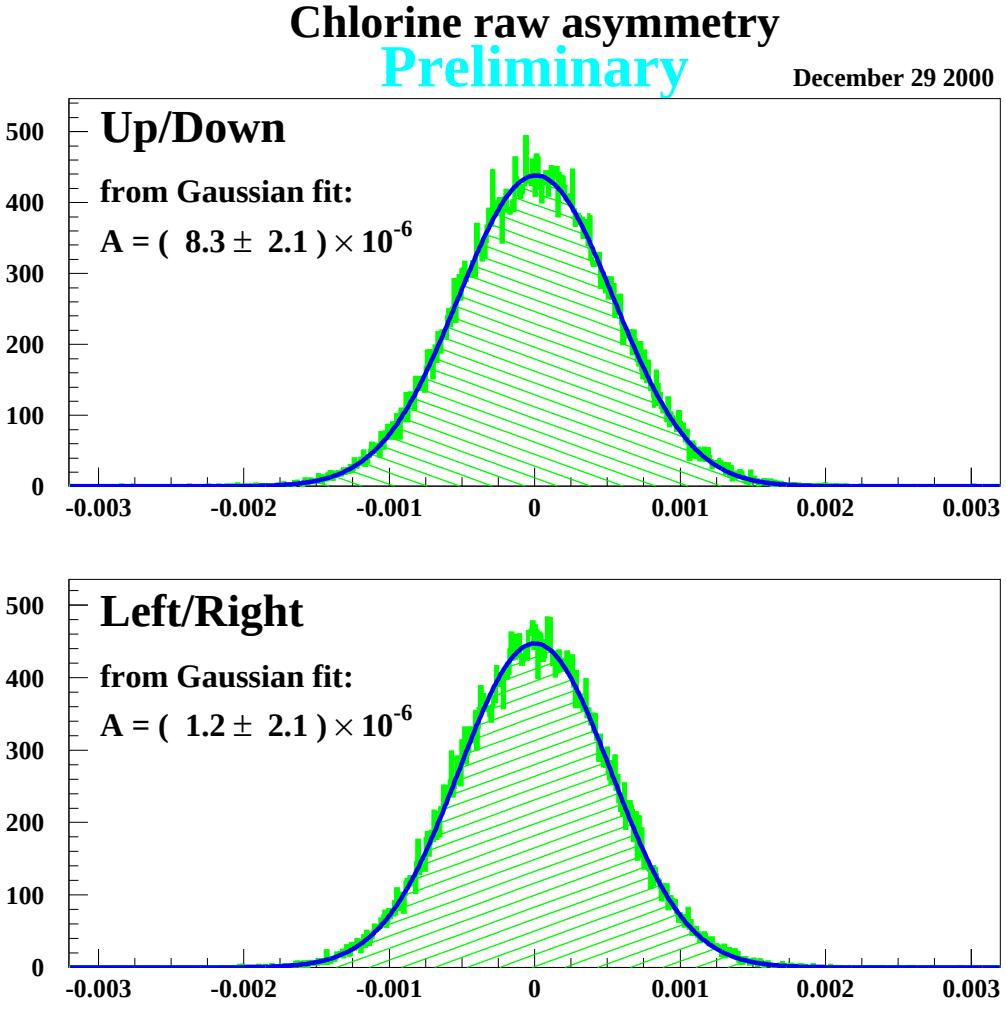
48 of these detectors will be used in the full experiment





Parity-violating up/down asymmetry in Cl

(also measured A_{UD} & A_{LR} on Cd and La)



correction factors: 1/<neutron polarization> = -2.56
detector 1/<cos θ> = 1.11

Physics asymmetries: U/D = (-23.6 ± 6.0) × 10^{-6}
L/R = (-3.4 ± 5.9) × 10^{-6}

Last Engineering Run 2001 Goals

FP11A

- Verify DAQ/detector noise improvements

Noisy power supplies, ground loop problems in previous test run–NPDGamma needs orders of magnitude better

Have a new RFSF power amplifier, new DC/DC converter design for photodiode preamplifiers–should see significant improvement

- Test larger ^{3}He system(s)

Larger cell–NIST, valved cell design–UM

- Test fission flux monitor

New current mode ^{235}U fission chamber

- Measure moderator brightness

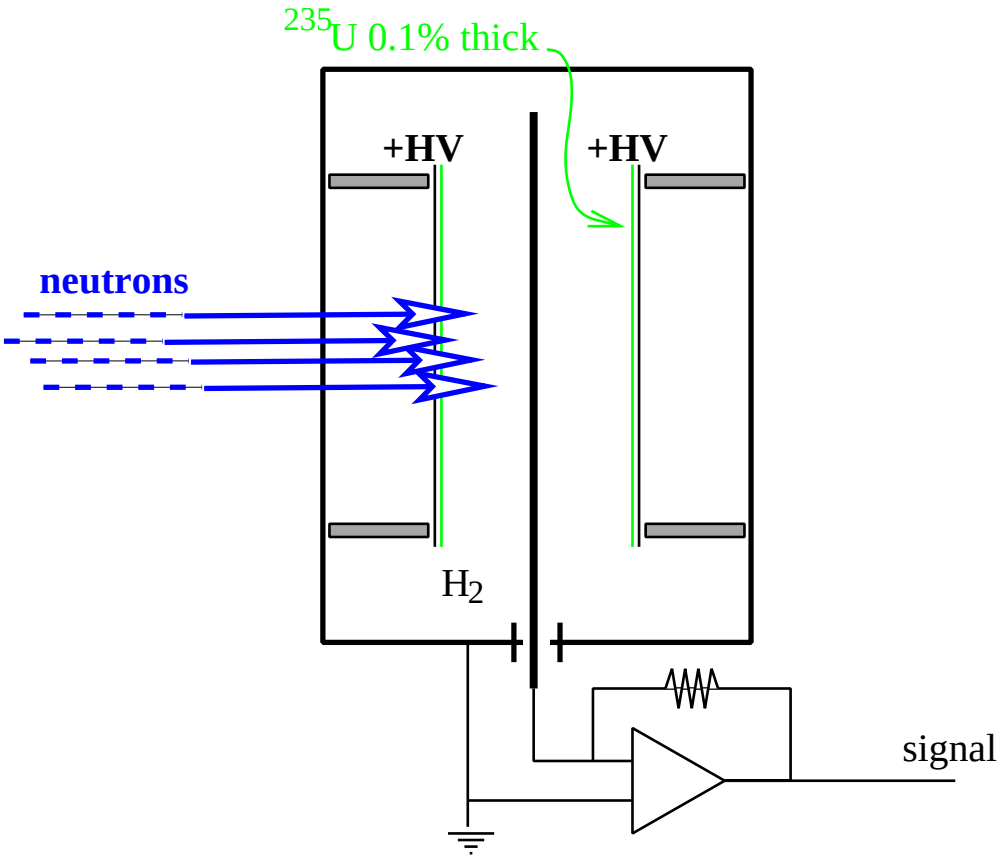
Tightly collimate beam to eliminate neutrons reflected from the guide walls

- Remeasure intensity fluctuations

Better toroid pickoff & instrumentation

- Test detector alignment scheme

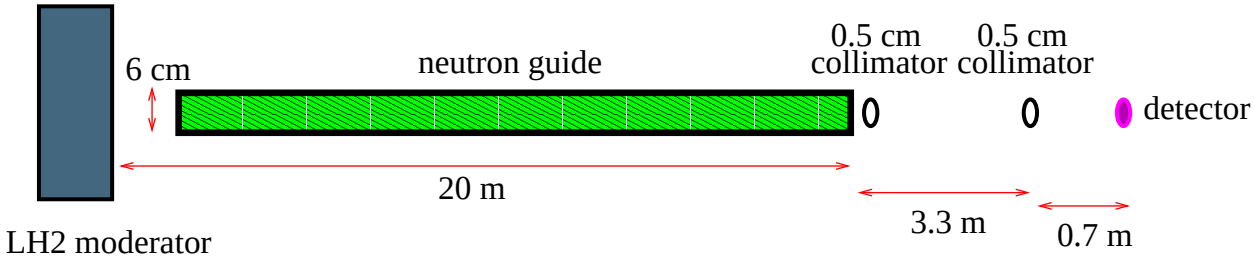
^{235}U Fission Monitor

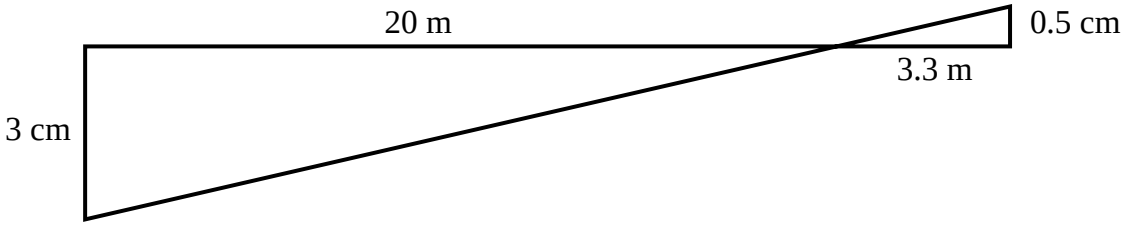


Moderator Brightness Measurement

Collimate the beam to eliminate neutrons reflected by the guide

Use a small detector to image the moderator directly





2001 Request for Lujan Center FP11A:

5 days setup

14 days beam

Schedule for Last Engineering Run

days	task
5	Setup
3	^{3}He system tests
5	Noise/background studies
2	Intensity fluctuation studies
2	Moderator brightness measurement
1	Fission monitor checkout
1	Test alignment scheme